

# PATENT SPECIFICATION

DRAWINGS ATTACHED

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## COMPLETE SPECIFICATION

### Corona Protection Screen for Inductor Coils of Vacuum Furnaces

5 We, ALLMANNA SVENSKA ELECTRISKA  
AKTIEBOLAGET, a Swedish Company, of  
Vasteras, Sweden, do hereby declare the in-  
vention, for which we pray that a patent may  
be granted to us, and the method by which  
it is to be performed, to be particularly de-  
scribed in and by the following statement:—

10 In vacuum furnaces in which the heating  
is brought about by means of an inductor  
coil, it is extremely difficult to prevent flash-  
over between the coil and surrounding parts  
of the furnace. The reason that particular  
15 problems regarding the occurrence of flash-  
over are present in vacuum furnaces is that  
the rarefied atmosphere has poor electrical  
insulation properties, and therefore corona,  
i.e. electrical gas discharges which can develop  
into flashover, easily arises.

20 So that corona shall not arise on the parts  
under voltage, either on the furnace coil or  
on the connection leads in the vacuum cham-  
ber, these parts are usually electrically in-  
sulated and provided around the insulation  
25 of the coil conductor with a corona protec-  
tion screen which may, according to known  
techniques, consist of a number of conducting  
layers displaced with respect to one another  
in the longitudinal direction of the conduc-  
tor and insulated from each other within  
30 the coil so that the electrical voltage in-  
duced in it through the field of the coil is  
divided. Out side the coil the layers are con-  
nected with each other and usually also with  
earth or with another potential under the  
35 critical voltage at which corona appears.

40 If a rupture occurs in the connection be-  
tween the layers or between a layer and earth  
potential or other potential under the critical  
voltage at which corona appears, for example  
because of mechanical damage or thermal  
strain, the layer receives approximately the  
same potential as that part of the copper  
conductor which the screen encloses. If a  
rupture arises within a layer, in a similar

manner, that part of the layer which after 45  
the rupture is not in connection with the  
other layers or with earth or another potential  
under the corona limit voltage, receives  
approximately the same potential as the copper  
conductors situated within this part. Such 50  
apertures result immediately in flashover  
phenomena so that the furnace can become  
unusable and the processes which the furnace  
is intended to carry out must be uncontroll-  
ably cut off. Apart from the necessity of 55  
re-insulating the furnace coils and possibly  
replacing or repairing other damaged parts,  
sometimes the material which is being pro-  
cessed in the furnace may have to be dis-  
carded, with the considerable economic losses 60  
which this entails.

The present invention relates to an induc-  
tor coil having a corona protection screen  
in which flashover phenomena do not arise 65  
as a direct result of a connection between  
any of its parts, or between these parts and  
earth potential or another potential under the  
critical corona limit voltage, ceasing to exist.  
The invention also includes a process for 70  
applying a corona protection screen to the  
insulation of the conductor of an inductor  
coil of a vacuum furnace.

According to one feature of the invention  
a vacuum furnace inductor coil comprises an  
electrical conductor, a coating of electrical 75  
insulation applied around said conductor, a  
corona protection screen applied on said in-  
sulation and comprising electrically conduct-  
ing or semi-conducting layers displaced with  
respect to one another in the longitudinal 80  
direction of the conductor and insulated from  
each other, and a tight and pore-free cover-  
ing of an electrically insulating material en-  
closing said electrically conducting or semi-  
conducting layers. Preferably the tight and 85  
pore-free covering consists of a wrapping of  
silicone rubber.

It is advantageous if this material has re-

sistance against corona. The conducting or semi-conducting layers are suitably attached to the insulation of the coil with a thermosetting resin. The expression "thermosetting resin" is intended to include not only resins which cure by heating but also resins which cure at room temperature, among others, completely polymerisable resins capable of curing at room temperature. These conducting or semi-conducting layers, further, can suitably be made up of metal, sprayed on, or varnishes containing suspended metal particles, in which case the spraying on of the metal or application of the varnish takes place while the resin is still uncured, so that a close connection between the insulation and the said layers is obtained. The resin is then transformed to cured condition, preferably before the conducting or semi-conducting layers are embedded in the insulating covering. If the connection between the layers or with the earth should be broken e.g. by mechanical damage and corona arises, the furnace will not be incapable of function since the covering is capable of resisting the strain arising so that flashover does not occur. Consequently, it is possible under these circumstances to continue the process taking place under the planned conditions and thereby obtain the result aimed at with the treatment in the furnace. The furnace need not immediately afterwards be taken out of operation, but it may still be used in the normal way, so that repair of the corona protection screen may be made at a suitable time. Whether damage of such a nature that corona arises has occurred can further be established through the observable corona phenomenon on the covering, which makes it possible to stop the process under complete control, if it is considered suitable. This may be the case, for example, if certain parts of the furnace are made of materials which are easily damaged by corona, or if for special reasons it is suspected that the risk of flashover might be present with continued operation. Because a fault arising can be detected before flashover takes place, damages resulting from such a phenomenon consequently can be avoided.

The invention will now be described, by way of example, with reference to the accompanying drawing, in which:—

Figure 1 is a side view of a part of a helically wound, vacuum furnace water-cooled inductor coil in accordance with the invention, which is electrically insulated and provided with a corona protection screen; and

Figure 2 is a section of a turn of the coil of Figure 1 taken along the line A<sub>1</sub>—A<sub>2</sub> of Figure 1.

The coil shown in the figures is only chosen as one example of a coil provided with a corona protection screen. In relation

to the diameter of the coil, the conductor cross-sectional area is enlarged.

From Figure 1 is clear, partly the shape on the coil 1, a turn of which is seen in more detail in Figure 2, and partly how the conducting or semi-conducting layers, within the coil are insulated from each other and outside the coil are connected with each other by leads 2, and with earth. The conductor consists of a copper pipe 3 which is internally cooled by water. Outside the insulation 4, which consists for example of a silicone varnish, an epoxy resin, an alkyd varnish, a phenolic varnish, an unsaturated polyester resin, or silicone rubber, is applied a base layer 5 for conducting or semi-conducting layers 6, 7 and 8, which together with a covering 9 of a tight, pore-free and corona-resistant material, form the corona protection screen. An insulating material 10 is applied on the outside for protection against mechanical damage. The insulation 4 may also consist, e.g. of a wrapping of glass fibre tape impregnated with one or more of the above mentioned resins and varnishes or of a wrapping of silicone rubber tape reinforced with a glass fibre tape. The ground layer 5 consists in the exemplified case of a wrapping, e.g. with half-overlap, of a woven glass fibre tape, e.g. having a width of 19 mm and a thickness of 0.08 mm. After the glass tape has been applied to the insulation of the coil, an epoxy resin is applied, for example the epoxy resin known under the Trade Mark "Araldite XV" with "Curing Agent XV" from Ciba AG., which components are previously mixed in the proportion of 100 parts by weight of the first mentioned and 30 parts by weight of the last mentioned. The last mentioned epoxy resin is of the bisphenol type dissolved in a solvent, and the curing agent is of the anhydride type and is also dissolved in a solvent. Heating-curing as well as room-temperature-curing resin may be used. Instead of the exemplified epoxy resin other heat resistant thermosetting resins may be used such as other commercially available epoxy resin, silicone resin, or saturated or unsaturated polyester or phenolic resin. After solvents in the mixture have evaporated, but before the resin is cured, the conducting layers 6, 7 and 8 are applied, which layers may consist of lead and be applied by flame spray. They could also be constituted, for example, by varnishes containing suspended metals such as aluminium and silver in powder form. Each metal layer 6, 7, 8 encloses in this example, as is clear from Figure 2, 3/4 coil turns and is insulated from the metal layers 6 and 8 in the adjacent 3/4 coil turns by insulations 11 and 12 of the same type as the insulation 4. The metal layers are connected to each other outside the coil. From Figure 2 is seen particularly how the metal layers 6 and

7 are connected with each other via the connections 13 and 14 and the leads 2. The covering 9 may advantageously consist of a non-reinforced silicone rubber tape or of a  
 5 silicone rubber tape containing a reinforced glass tape, for example of Westinghouse "Silastic" Tape 9495—12 having a width of 19 mm and a thickness of 0.25 mm from Westinghouse Corp. The silicone rubber tape  
 10 may, for example, be wound in two layers with half-overlap. The winding must be done with the greatest care so that each part is covered by at least one tape thickness, and the bandage obtained is completely tight and  
 15 pore-free. The outer protection 10, the main purpose of which is to protect the insulated coil, provided with the corona protection screen, from mechanical damage which may arise during transport, manipulation and  
 20 mounting of the coil, may for example consist of glass tape with an adhesive material, or a silicone rubber tape reinforced with a woven glass fibre tape such as Tape No. 659 from Vernon Chemical and Mfg. Corp., having a  
 25 width of 19 mm and a thickness of 0.15 mm. This tape may, e.g. be applied with half-overlap. If the covering 9 itself has sufficient resistance against mechanical damage, the protection 10 may be dispensed with. The resin  
 30 used for attaching the metal layers to the insulation of the coil is suitably cured after the layers have been sprayed on, but curing may also be referred until the layers are covered with the tight and pore-free material.  
 35 **WHAT WE CLAIM IS:—**  
 1. A vacuum furnace inductor coil comprising an electrical conductor, a coating of electrical insulation applied around said conductor, a corona protection screen applied  
 40 on said insulation and comprising electrically conducting or semi-conducting layers displaced with respect to one another in the longitudinal direction of the conductor and insulated from each other and a tight and

pore-free covering of an electrically insulating material enclosing said electrically conducting or semi-conducting layers. 45

2. A vacuum furnace inductor coil as claimed in Claim 1, in which, said tight and pore-free covering of a wrapping of silicone rubber. 50

3. A vacuum furnace inductor coil as claimed in Claims 1 and 2, in which said corona protection screen is attached to said insulation of the conductor with a thermosetting resin. 55

4. A vacuum furnace inductor coil as claimed in Claims 1 to 3, in which said conducting or semi-conducting layers consist of layers of metal or of a varnish containing metal powder. 60

5. A process for the application of a corona protection screen on the insulation of the conductor of an inductor coil for a vacuum furnace, comprising applying a thermosetting resin on said insulation, whereafter, while said resin is still uncured, layers of conducting or semi-conducting material displaced with respect to one another in the longitudinal direction of the conductor are applied to the resin, whereupon said layers of conducting or semi-conducting material are covered with a tight and pore-free covering of an insulating material preferably after said resin has been transformed to cured condition. 65 70 75

6. A process as claimed in Claim 5, in which said tight and pore-free covering consists of a wrapping of silicone rubber.

7. A vacuum furnace inductor coil constructed and arranged substantially as hereinbefore described, with reference to, and as illustrated, in the accompanying drawing. 80

8. A vacuum furnace comprising the inductor coil claimed in any one of Claims 1, 2, 3, 4 or 7. 85

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Fig.1

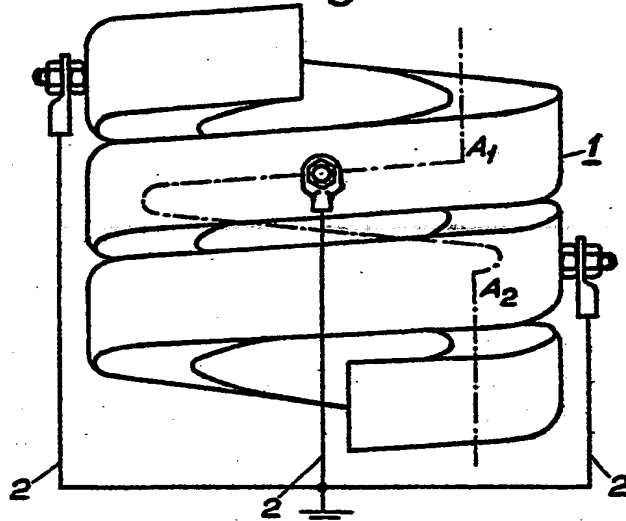


Fig.2

